

Mission Design Aspects of Planetary Entry Probe Missions

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As planetary entry probes travel to and approach their destinations, their flight paths are governed by the fundamental and well-understood physics of macroscopic bodies in motion. This facet of physics, even its subtleties, can be modeled very precisely by relatively simple equations, so extreme accuracy is possible. But the first-order motion of entry probes is in no way subtle: speeds are at least kilometers per second, sometimes tens of km/s, occasionally more than 50 km/s. This, coupled with the limits of our technologies, means that mission design considerations can place rather severe constraints on where and when probes can enter a given planet's atmosphere. They also determine many more detailed aspects of the entry, such as minimum entry speeds, tolerable entry flight path angles, entry location uncertainties, data relay geometries, etc.

Entry probe mission design usually is considered complete when the probe begins experiencing significant aerodynamic forces. Most mission designers consider the remainder of the probe's flight path a problem for aerodynamicists and planetary atmospheric scientists. But after probe entry the flight path of associated vehicles such as data relay spacecraft are still the mission designer's bailiwick, and natural, physical constraints on those flight paths can have serious implications for the conduct of the probe's mission.

This presentation will cover many of the problems and choices facing the mission designer when conceiving new entry probe mission designs. Examples of topics addressed are the locus of feasible entries for a given approach, the cost of modifying natural approach circumstances, planetary rotation and its implications for prograde and retrograde entries, entry upon hyperbolic approach vs. entry after insertion into orbit, and communications geometries.